THE TELEGRAPHIC JOURNAL.

Vol. II.—No. 30.

MEMOIRS ON ELECTRICAL SCIENCE.

Our readers will notice that in the present number, under the heading "Electrical Notices from English and Foreign Journals," we have commenced to give the titles of all papers on Electricity and Telegraphy which have appeared during the present century. These titles will, we trust, be of great value to those electricians who devote a portion of their time to original research, by enabling them to readily ascertain all that has been previously published on whatever branch of Electricity they may intend to investigate. The plan will also, with the abstracts which appear in each number of the Journal, form a complete index to the periodical literature of electrical science.

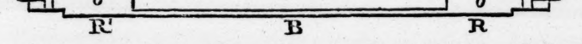
ON DUPLEX TELEGRAPHY, WITH PNEUMATIC APPARATUS.

The simultaneous transmission of signals in opposite directions in the same electric telegraph wire has become, as our readers are aware, a realised fact.

It is also possible to obtain the same effect with a telegraph of compressed air, and the following is an arrangement for the purpose, described by M. Marcel Deprez, in a recent number of the *Journal de Physique*.

The two reservoirs of air R and R′ are formed each in two divisions a, b, and a', b', separated by an elastic membrane, ef, $e'f'$. The pistons c, d, and c', d', used in sending signals, compress the air in the two divisions, as indicated in the figure.

The surfaces of the pistons c and d of one of the reservoirs R are in the same proportion to each other as the volumes of air a and $b+B+b'$, a being the volume of the upper part of one reservoir, b that of the lower part, B the volume of the tube of communication, and b' that of the corresponding lower part of the other reservoir.



The rods of the pistons c and d are in one piece, and their displacements are equal. It is easy to see that if this double piston cd be pushed, the masses of air on which the two pistons act being compressed proportionally to their volumes, their respective pressures will (in virtue of Mariotte's law) increase in the same proportion, and consequently will remain equal, if they were so originally; so that the membrane ef, which divides the reservoirs R, being equally acted on in both sides, will not be at all displaced.

But it will be otherwise with the membrane $e'f'$ placed in the reservoir R′. If the piston d' do not yield under the action of compression exerted in b', the membrane $e'f'$ will be raised; for it will receive the action of the compressed air in b', while the pressure of the air in a' will not be altered. This membrane bears a rod g', and the signal produced by displacement of the pistons a and b is thus transmitted to the exterior.

If the pistons a' and b' be displaced in one direction or another (supposing them in one piece, and made on the same principle as the other double piston), their displacement will not have any action on the membrane $e'f'$, and will not affect the movement imparted to it by displacement of the pistons a and b at the other station; but, on the other hand, there will be displacement of the membrane ef at that station.

Thus, then, each movement of one of the couples of pistons will be indicated by a corresponding movement of the membrane in the other reservoir, and that even during the time the pistons of the reservoir containing that membrane are themselves in movement.

The apparatus so arranged, therefore, fulfils all the conditions for simultaneous transmission of signals in the two directions.

RESEARCHES ON THE POLARISATION OF ELECTRODES, BY CHLORINE AND BY HYDROGEN.

An experimental investigation of this subject has recently been made by Dr. Macaluso in the laboratory of Prof. Wiedemann, of Leipzic.

To examine, first, the electromotive force of platinum charged with small quantities of chlorine, he immersed two plates of the metal in vessels filled with pure chlorhydric acid; and then slowly added, drop by drop, to one of the vessels, a quantity of the same acid, saturated, this time, with chlorine, leaving the other solution constant. Then he measured the electromotive force by Wiedemann's method for comparing the electromotive force of any couple with a Daniell element.

The results are these:—

(1). The electromotive force between the two plates, one in the pure chlorhydric acid, the other in acid containing free chlorine, is not constant, but gradually increases with the time to a maximum.

(2). It grows with the quantity of free chlorine to a certain value, about 0·62 Daniell, which it rarely exceeds.

(3). If immersion of the plate in the acid solution precedes the addition of chlorine, the electromotive force quickly increases from the time this addition begins, and nearly in proportion to the quantities of chlorine added, and tends gradually to a maximum.

(4). If, again, the plate is immersed in a solution already holding chlorine, the electromotive force increases first but slowly, on addition of the first drops of the chlorine solution; and it is only by degrees that the increase of electromotive force assumes the progress described in No. 3.

To explain these facts, the author supposes the force only depends on the quantity of chlorine condensed on the surface of platinum, and not on that which it finds in the solution; further, he thinks, that the platinum and the glass exert a much greater attraction on the chlorine than the liquid, and that this attraction is twenty-five times stronger with the platinum than with the glass.

Dr. Macaluso next examines the electromotive force of polarisation resulting from deposit, on a platinum electrode, of a certain quantity of chlorine produced by electrolysis of an aqueous solution of chlorhydric acid.

The results here obtained are as follows:—

(1). The polarisation thus produced is greater than that of a platinum plate immersed in chemical chlorine (prepared by means of peroxide of manganese, and chlorhydric acid then added in form of solution).

When a current is passed through a fresh solution of chlorhydric acid previously saturated with chlorine, the polarisation by the electrolytic chlorine is at first, for a certain time, constant, and very little more than the polarisation by chemical chlorine. Then it rapidly increases, and tends asymptotically to a maximum.

(2). When a platinum plate is immersed in a solution in which, a little before, chlorine has been liberated by the electrolytic method, a slightly greater electromotive force is obtained than by immersion of this same plate in a saturated solution of chemical chlorine. The longer the current which liberated the chlorine has lasted, the less necessary is it to prolong it further, to come anew to the point at which the polarisation commences to increase.

The facts enumerated may arise from the electrolytic chlorine, and the chemical chlorine having different properties, and being distinguishable, in some sort, from each other, even when the chlorine deposited electrolytically on the platinum electrode has already left it some time, and spread throughout the solution. The author is convinced, by special experiments, that this difference is not due to a change of the electrodes, nor to impurities of chlorine arising, *e.g.* from the transmitting tubes, nor to the formation of chloride of platinum, nor to an oxidation of chlorine, nor, lastly, to a change of the degree of concentration of the liquid. Accordingly he is brought to the conclusions which follow:—

(3). Chlorine developed on a plate of platinum by the galvanic current has a greater electromotive force (negative) than chlorine prepared by the ordinary process. It behaves with reference to the latter like active ozonised oxygen to ordinary oxygen.

(4). The electromotive force, developed between a plate of platinum charged with this active chlorine and another charged with ordinary chlorine is equal at the most to 0·46 of that of a Daniell element; while the electromotive force between a plate charged with ordinary chlorine and a plate of pure platinum, immersed in chlorhydric acid, is equal to 0·62. The electromotive forces developed in the latter case, and in the case of an electrode of pure platinum, connected with another charged with active chlorine, are thus, one to the other, in ratio of 1 : 1·7.

Experiments as to the influence of degree of concentration of chlorhydric acid, of temperature, and of the time at which the polarising current has passed, led to results as follows:—

(5). The polarisation by electrolytic chlorine reaches a maximum more rapidly in dilute solutions of chlorhydric acid than in concentrated solutions; but in very dilute solutions, the absolute value of this maximum is independent of the degree of concentration. A too high degree of concentration prevents the polarisation by electrolytic chlorine from attaining its maximum.

(6). In concentrated chlorhydric acid, the polarisation by electrolytic chlorine diminishes more rapidly after interruption of the polarising current than in dilute acid. The presence of a much larger quantity of chlorhydric acid, therefore, causes a more rapid return of active chlorine to the state of ordinary chlorine.

(7). By an elevation of temperature comprised between 17° and 100°, the polarisation of platinum charged with ordinary chlorine diminishes by a quantity equal to only 0·062 of a Daniell couple, whereas, between 16° and 93°, the polarisation of platinum charged with active chlorine undergoes a much greater diminution—equal to 0·449 of the electromotive force of a Daniell couple.

(9). It is only on the platinum plate, at the surface of which it has been developed, that active chlorine produces so intense a polarisation; and it cannot pass by diffusion to another plate.

On opening and closing the current several times in succession, one finds, at first, the polarisation by active chlorine increase very quickly to near its maximum, which it thereafter reaches slowly.

This slow increase may, perhaps (it is thought), be explained by the fact that the active chlorine is only a small portion of the total mass of chlorine developed by the current, and that this proportion is smaller the more concentrated the solution; that, moreover, this modification of chlorine has the property of penetrating into the pores of the platinum, and condensing there. When the electrodes are perfectly clean, and the solutions have such a degree of concentration that the proportion of active chlorine is very small, this is at the first completely absorbed by the electrode. The electromotive force of polarisation can only begin to increase when the platinum is in part saturated. It is sufficient, indeed, that it be partially saturated, for, since a minute after interruption of the polarising current the chlorine loses its activity, the maximum of polarisation by electrolytic chlorine can only be produced by the active chlorine developed in the last minute before interruption of the current.

It is observed that once the polarisation has commenced to increase, it continues doing so at least three hours before reaching its maximum. This would indicate that a portion of the active chlorine developed by the current is absorbed, in a measure, by the pores of the platinum, and that this portion, absorbed every instant, is smaller the nearer the plate comes to its maximum of saturation. Of the quantity of active chlorine, then, liberated in the last minute before observation, there is a quantity, always increasing, which remains at the surface of the electrode, to produce in it an ever-increasing polarisation. This must, then, if such be the case, tend very gradually to a maximum.

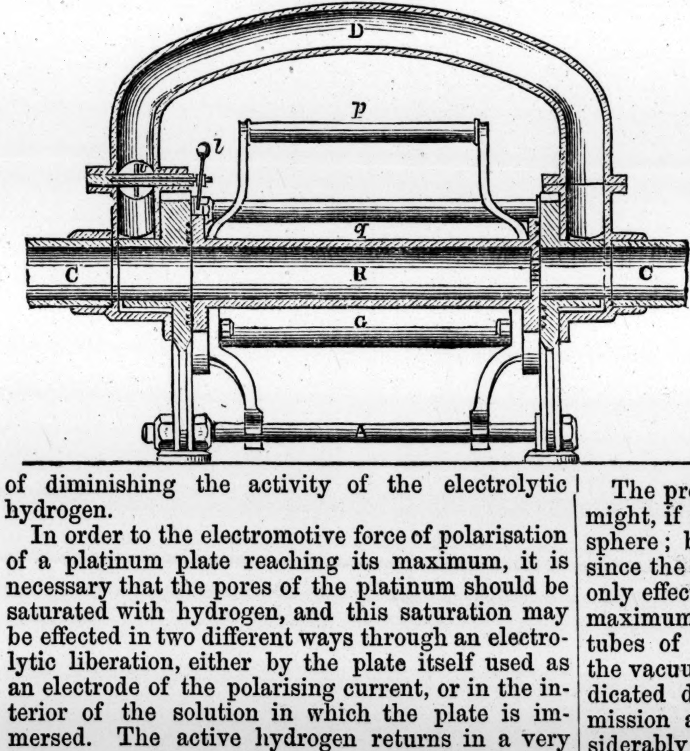
Hence, it follows that if the concentration of the solution be such that a considerable portion of the electrolytic chlorine is active chlorine, this will not be entirely absorbed in the measure in which it is developed, but will remain, in part, at the surface of the electrode from the commencement, so that, beginning at the moment of closure of the principal current, the polarisation will increase and tend rapidly to a maximum.

Coming next to polarisation by hydrogen, the author made experiments similar to those in the case of chlorine, and they showed what follows:—

The electromotive force developed between two platinum plates both immersed in chlorhydric acid, the one being pure, and the other charged with hydrogen, produced chemically, oscillates between 0·63 D. and 0·70 D., according to the degree of concentration of the acid. It is smaller the more concentrated the acid. This force is much greater when the hydrogen condensed at the surface of the electrode has been developed electrolytically; it then reaches 0·94 D. instead of 0·68 D. It increases, in this latter case, with the time the polarising current has lasted, and reaches a maximum which, for dilute acid solutions, is independent of the degree of concentration. A too high degree of concentration hinders the formation of active hydrogen which produces this greater electromotive force.

When the current meant to produce the hydrogen by electrolysis is sufficiently strong, the temperature has no influence on the electromotive force of polarisation. On the other hand, when the current is weak, an elevation of temperature has the effect of diminishing the activity of the electrolytic hydrogen.

Fig. 3.



In order to the electromotive force of polarisation of a platinum plate reaching its maximum, it is necessary that the pores of the platinum should be saturated with hydrogen, and this saturation may be effected in two different ways through an electrolytic liberation, either by the plate itself used as an electrode of the polarising current, or in the interior of the solution in which the plate is immersed. The active hydrogen returns in a very little time,—about a minute,—to the state of ordinary hydrogen. This change is effected more quickly the greater the concentration.

The author obtained quite similar results on using carbon electrodes instead of platinum; only in this case the polarisation tends to its maximum immediately after closure of the electrolytic current.

It is announced that Captain Davies, managing director of the Exchange Telegraph Company, and Mr. J. L. Shuter have joined the Board of the Electric Power Company (Limited).

REPORT OF M. DELARGE ON THE SYSTEM OF PNEUMATIC TUBES EMPLOYED IN ENGLAND.

(Continued from p. 114.)

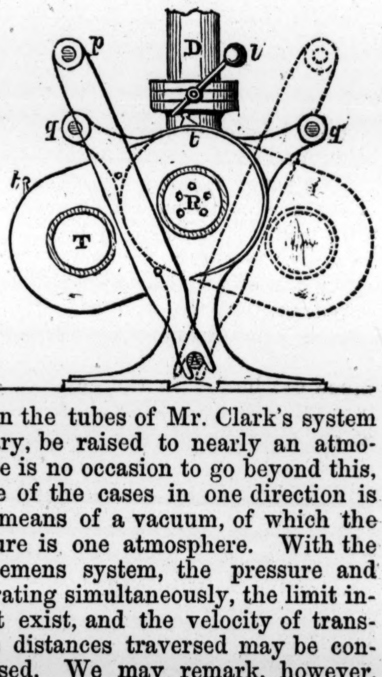
The machines for compressing air and making a vacuum for all the tubes in service (including those of the Siemens system) are placed in the cellars of the central office. Sheet iron reservoirs serve to store up the compressed and the rarefied air, so that variations of pressure, at each sending of a case, are not sensible.

For the compressed air, the dimensions of reservoirs are as follows:—(1). A cylindrical reservoir with a 2·59 m. diameter and 3·40 m. height,—its volume is 17·884 cub. m.; (2). A reservoir of the same force and section, but only 2·74 m. high,—its volume is 14·412 cub. m. They are fixed, and have a stopcock below, by which any water that may have collected through compression is let off every night.

The reservoirs for rarefied air are also two in number, the one having a volume of 17·884 cub. m., and the other 4·453 cub. m.

The excess of pressure of compressed air over exterior air varies from 0·40 atm. to 0·70 atm., and the excess of pressure of exterior air over the rarefied air varies from 0·47 atm. to 0·81 atm.

Fig. 4.



The pressure in the tubes of Mr. Clark's system might, if necessary, be raised to nearly an atmosphere; but there is no occasion to go beyond this, since the passage of the cases in one direction is only effected by means of a vacuum, of which the maximum pressure is one atmosphere. With the tubes of the Siemens system, the pressure and the vacuum operating simultaneously, the limit indicated does not exist, and the velocity of transmission and the distances traversed may be considerably increased. We may remark, however, that from the point of view of theoretical useful effect, and diminution of loss of air, there is an advantage in employing only weak pressures. It is well, then, in each particular case, to employ only the pressure strictly necessary. Another disadvantage of high tension is the complication of compressors, which must be furnished with plunger pistons like those used by Sommeiller in boring a tunnel through the Alps. The valves and other fittings of ordinary blowing machines cannot, indeed, resist the high temperature produced in compression of the air.

The blowing cylinder is in prolongation of the steam cylinder. It is a double-action one with ordinary valves. The compression of air is produced on one side of the piston and the vacuum on the other side.

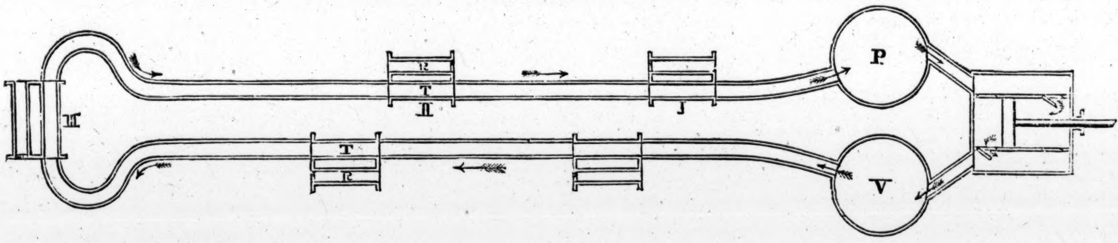
We come now to describe the tubes of the Siemens system.

As has been stated in the beginning of the report, two tubes forming a complete circuit are placed between the two extreme offices that are to be in communication.

Intermediate offices may be intercolated in the circuit. To send a case from any point of the line it is simply introduced into the tube by means of certain valves, and the office to which the case is to go, being warned by an electric signal, stops the case in its passage by means of these valves.

Several circuits of the kind, comprising each a number of intermediate offices, may be connected by their extremities with the office supplied with machines. The extremities of such circuit are in permanent communication, one with a reservoir of compressed air, the other with a reservoir of rarefied air, so that the velocity of transmission thus obtained is evidently greater than with merely a vacuum, or compressed air.

Fig. 5.



The pipes forming the tube are of tilted iron. They are 0·076 m. internal diameter, 0·004 m. in thickness, and 5·70 m. in length, are bored in the interior, and are connected by means of iron cylinders, of which the interior cylindrical part is bored, so that the two extremities of the pipes fit exactly one against the other. The junction is completed by a packing of hemp and lead. The pipes are buried in the earth at a depth of about 0·30 m., with an inclination towards drains situated at certain intervals for collecting water condensed in the pipes. These consist of iron cases, terminating in a pipe of the same diameter with those of the tube. A tube, closed with a nut at the upper part, communicating with the drain, and ending in a small iron case at the street level, permits of removing the water at will.

The despatch cases, which are similar to, though larger than, those employed in the Clark system, have a gutta-percha cover held by an elastic band; and a second envelope of felt terminating in a funnel is added to the extremity of the case.

The valves for reception and transmission are shown in Figs. 3 and 4.

As may be seen from the sketch, Fig. 4, each of the pipes forming the tube is furnished with a complete valve. This consists simply of two pieces of pipe T and R, of the same internal diameter with the tube, and borne by a frame which is movable about an axis, A. One or other of these pipes is interposed at will into the circuit, according as a case is to be sent or to be received. The pipe T being hollow throughout, a case to be dispatched has merely to be placed in it, and the pipe is then brought into the prolongation of the tube, by raising the handle *p*. The air current carries the case away, immediately this position (represented by dotted lines in Fig. 4) is reached.

The position of reception is that traced in full lines in the same figure, and represented in Fig. 3. The pipe R, which is then in the continuation of the tube, is furnished at one end with a bottom pierced with small holes. On coming into this pipe, the case compresses the air in it, and instantly loses its velocity; the compressed air escaping by the holes does not acquire a tension sufficient to drive the case back. The case, on its arrival in the pipe R, intercepting the passage of the air current in this pipe, a branch tube, D, facilitates the circulation of the air. A small valve, *v*, which is wrought by the lever, *l*, and the blocks, *t*, on the movable frame, opens when the latter is in the receiving position, and closes when a case is being dispatched. Two fixed iron bars, *q*, limit the movement of rotation of the frame, and connect, in an invariable manner, the two fixed parts of the apparatus. To facilitate the operation, a pedal which one pushes the same time that he draws the handle, *p*, may be added to the apparatus. This is not represented in the drawings. The receiving box, R, has, in part of its length, a flat glass cover, which may be raised, when necessary, to take out the cases. The apprentice in charge can through it perceive immediately the arrival of a case. He then draws towards him the movable frame, and brings out the case by means of a rod.

When a case has to pass an office without being stopped, the apprentice, having been informed of its destination by electric signal, places the frame in its position of transmission. In passing, the case presses a spring in the interior of the pipe T, connected with a small rod traversing this pipe. The rod striking a bell announces the passage of the case.

The electrical apparatus of M. Tyer, for transmission of the signals necessary in manœuvring the valves, consists of an electric bell, a case containing electro-magnets, and two needles—one painted red, the other black, together with a special manipulator commanding the correspondent's bell. The black needle can only be put in motion by the correspondent, and indicates the signals received; the red needle repeats the signals sent, so that the operator himself controls the transmission.

The armature of the electro-magnets is a piece of steel or soft iron polarised by a magnet. After each passage of current, the needle retains its position in virtue of remanent magnetism, which is sufficiently intense to bring back the needle to the position which it occupies when one removes it with the hand from this position after the current has ceased to pass so as to falsify the signal received.

THE BLOCK SYSTEM.

What is understood by the block system is the absolute preservation of a definite space between the trains running on a line of railway, so that each train is protected from the one immediately following it by this interval. The term "block" system, however, thus applied, is not strictly correct. It should rather have been the "space" system, as contradistinguished from the "time" system, which is that system by which trains are maintained apart by an interval of time. The application of the term probably arose from the necessity of "blocking," or pinning the handle of the signalling instrument over in the earlier systems, and it has now become so deeply rooted in the phraseology of railway working that it is not at all likely ever to be eradicated. The principles of the block system may be generally stated to be the maintaining of trains apart upon the same pair of rails, secure from collision, by a certain and invariable interval of space. The practice of the system depends for its success upon the degree of perfection to which the apparatus used in carrying it out has been brought, the simplicity of the operations its working involves, the exactness of the rules and regulations devised for its working, the discipline maintained in enforcing these rules and regulations, and the carefulness with which the duties of the signalmen are performed. The principles of the system are absolute and unvarying; not so, however, its practice, inasmuch as on several lines of railway where it has been adopted different apparatus and different regulations are employed in carrying it out. This arises from the circumstance that several electricians have taken up the question and have worked it out to a practical issue, each in his own way, with a greater or less degree of success, and each railway has been working upon its own experience. The germ of the block system is traceable to Sir W. Fothergill Cooke, who developed the theory into practice as far back as 1842. Subsequently, about the year 1843, Sir W. Cooke practically applied the block system in the Queen-street tunnel, Glasgow. The next application of the principle was made by Mr. Edwin Clark, who adopted what is now known as the permissive block system on the London and North-Western Railway. This was a system intended not so much to increase the security of travelling as to increase the capacity of the railway for the transmission of its rapidly-increasing traffic. It consisted not in maintaining an absolute interval of space between following trains, but in checking the speed of a following train if it trenched too closely upon its predecessor. The permissive system may possibly expedite traffic on a line, because, under certain conditions, it permits a relaxation of the more stringent rules of blocking, but it takes away that absolute security to trains afforded by the block system in its integrity.

Another step in the development of the block system to produce signalling apparatus for working it was made by Mr. C. V. Walker, who introduced his method upon the South-Eastern Railway. The leading features of Mr. Walker's improvement was the introduction of a bell signal, Sir W. Cooke's system being based on the principles of the needle telegraph. Judging from results, the most perfect development of the block system is that worked out by Mr. W. H. Preece, and adopted on the South-Western Railway, of which line Mr. Preece was formerly and for many years the chief electrician. In place of the telegraph signals of Sir W. Cooke and the bell signal of Mr. Walker, Mr. Preece has visual signals, which are placed in the signal box, and which are an absolute reflex of what occurs outside, and, in some cases, out of the signalman's sight. His method of working the electric signals is precisely similar to that already adopted in working the out-door signals, and with which every signalman is so well acquainted. He in no way depends upon electric telegraphy for correctness of working, his system being based upon electric signals. Instead of telegrams passing to indicate whether the line is clear or blocked, a permanent signal is made behind each train to protect it from any following train, and what is more, the signalman does not make his own danger signal, but it is made by the man at the signal-station immediately in advance of the moving train, and he, moreover, alone has the power of taking it off. Two other names should be mentioned in connection with the development of the block system, and they are those of Mr. Tyer, who has done much good in this connection, and Mr. Spagnoletti, whose system is used on the Great Western and Metropolitan railways.

The block system of signals was first introduced by Mr. Preece, on the South-Western Railway, at Exeter, in 1860, since which time it has been gradually extended over the greater portion of the company's lines. The total length of the South-Western lines at the close of last year was 648 miles, out of which 480 miles were already protected by the block system, while 60 miles more were in course of being fitted, and in time the whole of the South-Western system will be fitted on this principle. The apparatus by which the signalling is carried on is a beautiful combination of mechanical and electrical principles—a combination which in practice has been found to produce the most unerring results. It fulfils in a very direct manner the following conditions, which may be taken as the leading requirements of the block system, viz.,—it supplies, first, a communication between two stations by which notice of the approach, progress, and departure of trains and their character is given; by it, secondly, a "danger" and an "all clear" signal is afforded for protecting and guiding the trains on each line of rails; thirdly, it gives the signalman at one station the sole and complete control over the signal at the other station, and renders it impossible for him to interfere with or alter the signal in his own box; fourthly, it ensures the proper acknowledgment of every signal, and that the acknowledgment shall not only imply the due receipt of the signal sent, but that it has been correctly understood and properly acted upon; fifthly, that the apparatus employed shall be unaffected by those atmospheric and cosmical causes which are so injurious to telegraphs generally; and, lastly, it provides that any derangement of the apparatus, or accidental delivery of a false signal, either by the signalman himself or by the mechanical interruptions to which wires are liable, shall at once indicate danger and thus produce safety. The first requirement is met by the use of an electric bell, so constructed that every current of electricity transmitted through the wires produces one blow upon it. By varying the number of currents sent—or, in other words, by the signalman pressing the piston of a small sounding apparatus, technically termed a key, a given number of times, a code of signals is formed by which the approach and departure of a train and the nature of the train are simultaneously announced at the next station. In the next place, it is required that there shall be two signals—one to protect the down line and the other the up line. The apparatus for this purpose consists of a semaphore placed in the signal box, and which, both in form and action, is a counterpart of that exhibited to the driver of the train on the line. In its normal condition the arm of the instrument is raised to "danger," in which position it is maintained by a small counterweight. By means of a current of electricity the arm is lowered to "all clear," and will remain down so long as a current flows. Directly the current ceases the arm flies up to "danger" again by the action of gravity, just in the same way and at the same moment that the arm of the ordinary line semaphore rises. The signal is under the sole control of the signalman towards whom the train is approaching.

The instrument by which the semaphore is lowered and raised is called a switch, from the similarity of its construction, appearance, and action to the switch handles for working the signals on the line. By moving the handle over from one side to the other, it places the battery in connection with the line wire, and thereby causes a current of electricity to flow, which lowers the signal. The principle by which the semaphores are actuated is the attraction of an electro-magnet, which simply does what the pull upon a wire effects on the line. This apparatus completely fulfils the third condition of a perfect signalling system. The signalman at one station has the sole control over the signal at the station next below him, and he cannot interfere with or alter his own signal by any movement of his own apparatus, nor can any accidental disturbance of his instruments affect it. The "all clear" signal in his box can only be given by the signalman at the station above him. Next, let us consider the fourth condition, which requires that every signal shall not only be acknowledged, but that the sender shall know that the receiver understands its import. In order to show how this condition is complied with it will be necessary to explain the process of manipulating the signals between two stations; and here it should be mentioned that the two stations need not necessarily be passenger stations, which on some lines are a considerable distance apart. Now, as the fundamental principle of the block system is that no two following trains shall be allowed to proceed in the same direction upon the same line of rails, between two signal-boxes at the same time, it follows that if these boxes were placed at the stations only, in some cases the traffic would be seriously impeded. The line between the stations is, therefore, divided into sections, signal-boxes being placed at the beginning and end of each section, so that two trains cannot be on the same pair of rails within any section at any one time.

To illustrate the working of the block system clearly, it will be best to give the following example of actual practice. The observations upon which it is based were made at Southampton and Bishopstoke and the intermediate signalling stations. The distance between the above-named places is five miles, and the intervening space is divided up into seven sections, each of the first four being about 400 yards, and the last three about a mile and a-half in length. The shortness of the sections is necessary here in consequence of the exceptionably heavy traffic passing over the line, as well as on account of numerous sidings and of the Dorchester branch, which is connected with the main line at two points. Omitting for the sake of clearness all the intermediate signal-boxes save one, let it be assumed that the observer is stationed in that one—say the Northam Junction, which is situate between Southampton and Bishopstoke. The first indication received by the signalman at the junction that a train is approaching him from Southampton is the warning signal, which is given on the bell by the signalman at the signal-box next below him between the junction and Southampton, and which indicates that the train has entered the section under the control of the intermediate man. This signal implies, "Train coming; look out," and it enables the signalman at the junction to see that the line is clear for traffic, and that both the electrical signals at the box below the junction and the out-door signals on the line at the junction are lowered for the train to pass. The line being thus cleared for its approach, the entry of the train into the section under the control of the signalman at Northam Junction is indicated by another signal on the bell from the signalman in the intermediate box. The electric semaphore arm and the out-door arm corresponding with it are then at once raised behind the train to protect it from being followed by any other train, and these signals remain up during the time the train is running through the section. When the train has passed out of the section the clearance of the line is indicated—first, by lowering the arm of the electrical semaphore, and next by a separate and distinct signal upon the bell. The outdoor arm is then lowered and the section is thus prepared for the second train to pass over it. The approach of every train is thus announced and its passage protected. It will therefore be seen that trains moving under the block system have their way prepared before them and their passage carefully guarded behind them.

In order to ensure accuracy it is imperative that every signal shall be acknowledged, and no signal is considered complete until it is acknowledged. It is, of course, very essential that the man at one box shall know not only that the arm has been lowered or raised at the further box, but that the man at that box has seen that signal and has acted upon it. This is effected by an automatic arrangement which renders a mistake simply impossible. It consists in a change in the direction of the current sent, which is effected by the instrument itself, entirely independent of the signalman, so that when he answers a signal the automatic action of the signal causes him to indicate the fact of the instrument having operated correctly by signalling back the words "On" or "Off," which are made to appear on an indicating instrument. This repeating arrangement is one of the essential features of a perfect block system.

Northam Junction is a point where the Weymouth trains enter the main line between Southampton and London. At all such points it is necessary to introduce an additional protection to prevent the possibility of two trains approaching the junction at the same time. Messrs. Saxby and Farmer's interlocking arrangements, recently described in the *Times*, have been introduced to prevent the possibility of the out-door signals giving false instructions to the drivers, so that when the signals upon the main line are lowered those upon the branch line are locked. Precisely the same arrangement has been introduced by Mr. Preece into his block system, so that when the main line is cleared for the passage of a main line train the branch line is locked and blocked.

In order to insure the proper protection of the train it is necessary not only that the signalmen should know that the electric semaphore at the distant station has acted properly, but that the distant signal which he himself works has also acted properly. This signal, though within 1000 yards of his box, may be out of sight, and in foggy weather is almost sure to be beyond his view. At night, again, it is more frequently hidden from his sight; hence it is very necessary that he should be able to ascertain whether it is in proper action. An electrical apparatus is therefore added to these signals, which indicates to the signalman that they have acted rightly, by day by simply actuating a small miniature signal—semaphore or otherwise—and by night by ringing a bell and indicating upon a disc the words "Light out" whenever the lamp, by any accident, has been extinguished. This last point is effected by the expansion or contraction of a piece of metal within the lamp, according as the light is in or out, and which causes electrical contact to be made or broken, and the condition of the signal to be thus indicated in the signal-box. It will therefore be seen that all the conditions and requirements which it is essential for a perfect block system to possess are fully met and satisfied in the apparatus and arrangements which have been described.

The block system as a whole, when worked upon the most perfect principles, requires the employment of three wires, and when so worked nearly every accident to which telegraphs are liable is eliminated. Motives of economy, however, have necessitated the introduction of block instruments which are worked by one wire. Opportunities are thus given for the entrance of the disturbing influences of atmospheric electricity, earth currents, and of those "moving accidents by flood and field" to which telegraphs are usually liable. The security of the block system is thus considerably weakened, but by a recent ingenious improvement, effected by Mr. Preece, even these causes of possible failure have been removed. This is effected by making the lowering of the signal, which is the emblem of safety, the result of the consentaneous action of the two men at the different ends of the section, so that no accidental current of electricity due to lightning, earth currents, or contact can produce a false signal. The apparatus by which this is effected is one of the most beautiful as well as recent combinations of mechanical and electrical science, and is now being adopted on all the branch lines of the South-Western system.

It has been asserted that the introduction of any form of the block system at once increases that element of danger—human fallibilty, to a very great extent. It is undoubtedly true that accidents have happened under the block system owing to forgetfulness or error on the part of the signalman. But these have invariably happened with imperfect apparatus worked under imperfect regulations and supervision. The whole tendency of the block system is to reduce the element of human fallibility to a *minimum*, and whatever probability there may be of an accident from this cause under the block system the probability of such an accident is very much greater without that system. It has been shown how a line is prepared for the approach of a train; how it is, as it were, closed behind the train; how these operations are governed and regulated by mechanical and automatic arrangements placed beyond the control of the signalman; and how if any error is made by him it is more likely to conduce to safety, and at the worst the delay of the train, than to accident. It is also urged against the block system that it removes the responsibility from the driver to the signalman, and that it tends to impair the careful look-out of the driver. The best answer to this is that those railway managers who have most extensively employed the block system disagree *in toto* with this opinion, and those who have used it longest are most decided in its praise. Captain Tyler, also, has stated that he does not find that the argument is justified by fact. It has also been argued that the introduction of the block system has a tendency to delay the traffic of a railway. Experience, however, has shown that the reverse is the fact when the length of the section is properly regulated according to the amount of traffic.

It cannot be too strongly impressed upon those interested in promoting the interests of the travelling public that the block system, theoretically and practically, tends to increase the safety of railway transit. Any failures that may have happened under its working are unquestionably due to imperfections in the mode of carrying it out. Mr. Malcolm, in his recent report to the Board of Trade, has truly stated as follows:—

"With regard to the block system, the criticisms passed on that proceed not upon the ground of the liability of mechanical arrangements to fail, but upon the assumption that it produces a feeling of false security among the servants who are working under it. This assumption is very generally made, and, indeed, admitted to some extent by Captain Tyler in his report, yet it is doubtful whether accidents traceable to it have hitherto occurred, while the accidents attributable to the want of the system are very numerous. Engine drivers are not more anxious than are any other class of persons to be burnt, scalded, or crushed to death, and I would submit that, if the use of this system is, in the language of Mr. Moore, 'liable to create a feeling of confidence in the men,' it would be difficult to discover a more forcible testimony in its favour than the feeling of security thus created."—*Times.*

PAPERS FOR JUNIOR STUDENTS.

Formulæ Analysed. By Arthur R. Granville.

V.—It is frequently necessary in practice to know the weights of cable insulators and conductors per mile; or, *vice versâ*, the diameters per mile of definite weights of materials when manufactured into cables. A prominent instance of this necessity is the calculation of the speed of signals, and, consequently, the estimation of the amount of practical work to be obtained. Such an estimate is dependent on the relative dimensions, or weights, of the conductor, the insulating compound, and the outside protecting iron sheath; for if the gutta-percha or india rubber is not in the requisite proportion to the conductor, a retardation of signals is the result. This retardation in the case of too thin an insulator arises from the inductive action of the current on the electricity in the earth or water, whereby a portion of the charge suffers friction (figuratively speaking), whilst another portion becomes bound,—the cable, in the latter respect, assuming the properties of a Leyden jar. Should, however, the insulating compound be excessive, retardation ensues from the phenomenon of electrification, which is an absorption of the current by the dielectric, after the fashion of a sponge.

A pound of gutta-percha measures $\sqrt{491}$ mils (*vide* "Latimer Clark and Sabine's Electrical Tables and Formulæ") when drawn out into a nautical mile length of rope, a mil being a thousandth part of an inch. A similar mass of Hooper's india-rubber compound measures $\sqrt{401}$ mils of sectional area; iron measures $\sqrt{62{\cdot}6}$ mils; and copper $\sqrt{55}$ mils.

From the following tabular list, the relative weights per knot, diameters of masses measuring 1 knot and weighing 1 lb., and the weight of a cubic foot of each substance, may be seen at a glance:—

	Weight per Cubic Foot in lbs.	δ_1 Diameter in Mils of 1 lb. Measuring 1 Knot.	δ_1^2 Square of the Diameter in Mils.	Weight of a Cylindrical Mass per Knot.
Copper	550	7·49	55	$\frac{d^2}{55}$
Iron	480	7·91	62·6	$\frac{d^2}{62{\cdot}6}$
Gutta-percha ..	61	22·16	491	$\frac{d^2}{491}$
India-rubber ..	73·44	20	401	$\frac{d^2}{401}$

The data in the first three columns are sufficient to enable us to ascertain the weight of either copper, iron, gutta-percha, or india-rubber, of whatever thickness, as per last column, and also, as I shall show, to ascertain their dimensions from their known weights or *bulks*.

Euclid (Book XII., proposition 2) demonstrates a fundamental theorem of the mathematical science that *squares are to one another as their diameters.* Upon this theorem may be said to rest the basis of the calculations to be explained; and, on account of the great importance of this proposition in every branch of physical science, it should never be forgotten. If, therefore, we wish to ascertain how much larger a circle d, 2 inches in diameter, is than another, d_1, only 1 inch in diameter, we simply square both dimensions; and as many times as one is greater or less than the other, so are their areas. In the example just mentioned—

$$\left.\begin{array}{l}2^2=4\\1^2=1\end{array}\right\}\therefore \tfrac{4}{1}=4,$$

the number of times that the area of d is greater than that of d_1. So, in general, the formula—

$$x=\frac{d^2}{d_1^2}\;.\;.\;.\;.\;.\;.\;.\;(1).$$

is the same result in algebraic language for all classes of similar calculations. Since, also, the weight is as the area or mass—

$$x=\text{weight}.$$

By reference to the table, it will be seen that the weight of a mile length of copper is represented by—

$$\frac{d^2}{d_1^2}=\frac{d^2}{55},$$

in which d=diameters in mils. For, since a diameter of copper wire, a mile in length, measures $\sqrt{55}$ circular mils of area weighs 1 lb., then it follows, from Euclid's theorem just quoted, that $\frac{d^2}{55}$ must equal the weight of the mile length of copper whose diameter is d. In like manner—

$$\frac{d^2}{62{\cdot}6}=\text{weight of iron per mile.}$$

$$\frac{d^2}{491}=\quad\text{,, of gutta-percha ,,}$$

$$\frac{d^2}{401}=\quad\text{,, of india-rubber ,,}$$

Hitherto I have referred to simple measurements of one substance: the principle is, however, the same even when two, three, or more, up to n substances as in a cable, are concerned. For instance, in a gutta-percha covered conductor, when we require to estimate the weight of a core of gutta-percha alone, the formula becomes—

$$\frac{D^2-d^2}{491}\;.\;.\;.\;.\;.\;.\;.\;(2).$$

in which D refers to the gutta-percha. Here it is evident that the subtraction noted in the numerator eliminates the weight of the copper d. So, by substituting for 491 in equation (2) the constant shown in column δ^2 of the table for the other materials, we obtain their several weights.

I have shown that $\frac{\delta^2}{\delta_1^2}=w$, the weight. Now, this value, by clearing of fractions, becomes—

$$\delta^2=\delta_1^2\,w\;.\;.\;.\;.\;.\;.\;.\;.\;(3).$$

Extracting the square root—

$$\delta=\delta_1\sqrt{w}\text{ mils}\;.\;.\;.\;.\;.\;(4)$$

a general formula, in which we obtain the unknown diameter of δ in mils, in terms of the known diameter δ_1. The known diameter of δ_1, is shown at once from the table, so that, by substitution, we find that the diameter of copper wire is $\delta=7{\cdot}49\sqrt{w}$; of iron wire, $\delta=7{\cdot}91\sqrt{w}$.

In a similar manner, for the diameter of any dielectric, the general formula is—

$$\frac{D^2-\delta^2}{D_1^2}=W\;.\;.\;.\;.\;.\;(5).$$

in which D_1^2=the square of the diameter of the dielectric in mils, *vide* equation (2).

To find the value of D, *i.e.*, the diameter of any dielectric, when the weight is given, we clear of fractions—

$$D^2-\delta^2=D_1^2\,W$$
$$D^2=\delta^2+D_1^2\,W\;.\;.\;.\;(6).$$

but δ^2, the diameter of the copper, has before been shown = to $\delta_1^2\,w$. Substituting this quantity in equation (6)—

$$D^2=\delta_1^2\,w+D^2\,W$$
$$D\;=\sqrt{\delta_1^2\,w+D^2\,W}$$
$$=\delta_1\sqrt{w}+D\sqrt{W}\;.\;.\;(7).$$

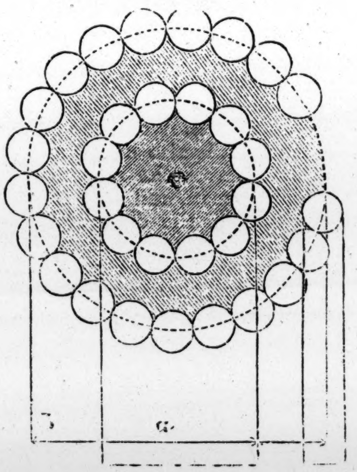
The diameter of any gutta-percha core is found by substituting the values of δ_1^2 and D_1^2, as per above table, to be—

$$=\sqrt{55\,w+491\,W},$$
$$\text{or }=7{\cdot}49\sqrt{w}+22{\cdot}16\sqrt{W},$$

and for india-rubber, in like manner we obtain $\sqrt{55\,w+401\,W}$, or $7{\cdot}49\sqrt{w}+20\sqrt{W}$.

In the woodcut below, a drawing is given of a section of a cable to which reference will be made in the next paper, and in which will be continued the formulæ relating to the weights of hemp, &c., outside the gutta-percha coating and inside the outer iron protecting sheath.

FIG. 2.



(To be continued.)

THE award of prizes to the successful students in the winter term at the Crystal Palace School of Practical Engineering took place on Saturday, Mr. C. W. Siemens, D.C.L., F.R.S., member of the Council of the Institute of Civil Engineers, presiding. Previous to the meeting the work of the students was exhibited in the workshops in the South Water Tower.

Proceedings of Societies.

SOCIETY OF TELEGRAPH ENGINEERS.

At the meeting of the Society held on the 22nd ult. Dr. C. W. Siemens, F.R.S., occupied the chair.

Sir William Thomson, F.R.S., explained his "*Method of Deep-Sea Sounding by Means of Piano-forte Wire.*" After a few introductory remarks he said—The great merit of wires compared with rope is the smallness of the area and the smoothness of the surface which the wire presents, as compared with the greatness of the surface and its roughness when rope is used with a comparable degree of strength. The wire that I have found suitable is piano-forte wire of the Birmingham gauge No. 22. It weighs about 14½ lbs. to the nautical mile, and bears from 230 lbs. to 240 lbs. pull without breaking. The quality of wire which I described to the meeting of the British Association at Brighton was special wire made for the purpose by Messrs. Johnson, the celebrated wire-makers at Manchester. They succeeded in producing a length of three miles in one piece of crucible steel, which certainly was a very great feat in the way of wire-making; and this wire was presented by them to me as capable of bearing a strain of about 230 lbs. I tested many specimens of it, and I found that none of them broke with a less strain than something like 220 lbs., and that many of them bore as much as 240 lbs. The wire then fulfilled all that the makers promised, and it had that quality which then seemed of paramount importance,—a great length in one piece of metal. The truth is, that one of the impossibilities was splices. I tried splices in first experimenting in this process, and by making a twist of two pieces of wire together in a somewhat long lathe, and running solder all along the interstices, I made a very good splice. However, on testing this splice, I found that, although it would bear within 10 lbs. or 20 lbs. of the full weight of the wire, yet in every case of a pull with longitudinal force, the wire broke. This was precisely in accordance with theory. In fact, I always found that this was the case. The result never differs from theory; that is to say, the theory is correct. The sudden change of area of set between the long cylindrical wire and the thickening produced by the solder is an essential element of weakness. That is a general character which is well known to engineers. Inevitably, if the wire is of uniform character, it breaks close opposite the solder. To avoid this weakening of the wire, an exceedingly gradual commencement of the pressure or force by which one piece of wire is connected with the other must be attained. The obvious way of obtaining this is by a very long splice. A splice of 2 feet long I have found quite sufficient. The splice I may describe shortly. The two pieces of wire to be spliced are laid, with one coinciding, approximately, 2 feet with the other. At the middle of the lap, one wire being held out firmly, 1 foot of the other wire is laid down with a very long spiral lathe. Then, turning to the other side, 1 foot of the other wire is laid down in a lathe of the same quality. That is to say, there is a right-handed screw on each side. The wire has been previously coated with marine glue, just to increase a little the surface friction. The wires are found to cohere perfectly when splices are made in that way, all that is necessary to make the splice permanent being to cover the ends over for about an inch with a serving of twine just to keep the ends firm down. I have tested scores of splices made in this way; and in no one instance did the wire break in the splice or near to it. It always broke some distance away, showing that the wire close to the splice was as strong as the other part of the wire; and of course in the splice itself the two wires together give a greater strength than exists anywhere else. The difficulty with regard to splice being altogether got over, we are freer in our choice of the wire to be used; and, accordingly, upon the advice of Mr. Johnson himself, I went on sounding with piano-forte wire. Therefore I have been driven back to that, and I find that it is of much better quality than other wire. Mr. Johnson tells me that it is impossible to produce in other kinds the same quality of wire as is habitually made by the best makers of piano-forte wire. He said that although he could produce wire of great strength, he found it impossible to attain the same temper as that of the piano-forte wire. Acting upon his valuable advice with respect to the quality of wire, I have now begun to use altogether the best quality of piano-forte wire. That which I now adopt seems to fulfil all the qualities we look for in a material. The first difficulty, and one which seemed in the first place an insurmountable difficulty, was the tendency of the wire to kink and break. The first thing is to endeavour not to let the wire kink, and, in the second place, if by any accident it does kink, it is desirable that it should not break. I found that the piano-forte wire, if pulled to a breaking strain, would stand, without breaking, a far greater strain than it was exposed to in any part of the sounding process; and, therefore, we felt, great security that even a bad kink would not be liable to break. The lengths which another firm supply of this wire are, I believe, 400 yards. You must take that with some reserve, but to the best of my memory 400 yards is the greatest length. But, however, a splice at 400 yards or 200 fathoms is no inconvenience whatever. The defect in the original apparatus to be remedied is in respect to hauling in by the whim,—this wire wheel which you see. It is in the same form that I have used all along. That is the original form of wheel, and the process of hauling is simply to coil it up. The wheel is about a fathom in circumference. My first sounding was in water of 2700 fathoms, in the Bay of Biscay. 100 fathoms was the deepest sounding marked on the chart. I made a careful sounding, so that there is no doubt about the figures. I found, in hauling in by winding it upon the wheel, that, after about 1500 fathoms had been taken in, the wheel began to show very serious signs of distress. The wheel was perfectly round and symmetrical at first, and when there was still about 800 fathoms out, it assumed very much the shape of an old sea cocked hat, and I had great difficulty in getting in the last 800 fathoms; and therefore, of course, the wheel and the work were not perfectly related to one another. I have made various attempts to overcome the difficulty. My first attempt issued in failure. It consisted in stopping the process after a certain number of fathoms, say 20 fathoms, taking the strain off the wire, and easing it round the wheel. It was done in a sounding of 1200 fathoms, made in Funchal Bay, Madeira, only a few miles from Funchal, during Hooper's cable expedition to Brazil last summer. I found that the process was, in the first place, exceedingly tedious. I found that stopping every 20 fathoms did not seem to be of any use at all, so I stopped at 10 fathoms, and it made a very long job in 1200 fathoms, and, besides, it did not afford sufficient accuracy. That plan being a failure, I then looked out for some other; and the peculiarity of the present apparatus consists in the way in which that difficulty was overcome. I may say that in the American navy another mode of getting over it has been followed. The wheel has been strengthened and the weight has been detached in the American soundings by wire. One of the trigger detaching apparatus has been used, and the weight has been reduced. That of course lightens the pull upon the wire very greatly. By those means —the strengthening of the wheel and the lightening of the pull—the Americans got over the difficulty very well. I, however, did not consider it desirable to throw away 30 lbs. or 35 lbs. of lead or iron at every sounding, and we found it well to do all we could, in moderate depths of 3000 fathoms, to bring back the sinker; and if we got into the way of doing that in 3000 fathoms, then we might be able to do it in greater depths. The *Challenger* failed in this respect, in taking soundings in the gulf stream; but by this process that which baffled the *Challenger* is made very easy. And there are greater depths, no doubt, than any which we have found. Perhaps we may have got near to the greatest depths. The *Challenger* has shown us 3500 fathoms, but I think that it would be rash to say that there are not depths of 5000 fathoms. I should wish, therefore, to do all we can without throwing away our sinkers in depths of 3000 fathoms. In the case of very great depths we might, perhaps, take a heavier sinker and detach it. In the meantime we have no difficulty in recovering the sinker from a depth of 3000 fathoms; and, having no difficulty, I prefer an apparatus which will in every case bring back the sinker. I will explain the method of doing away with the defect arising from the strain of the wire, experienced through having a heavy length of wire coiled up on the wheel, and a heavy pull. In the first place I shall describe the process of sounding from a ship hove to for the purpose of making the sounding, and I shall say a word or two in conclusion about flying soundings,—soundings made without stopping the ship,—which are of great importance in cable expeditions. But, in the first place, with regard to soundings when the ship is hove to, the sounding being the great object. Of course the ship is kept, as nearly as may be, at rest, and that is continued as long as is necessary for bringing up the wire and the sinker. The weight is attached by a piece of rope to a ring or clamp, the ring or clamp being attached to the wire. That is a first precaution which I introduced to avoid kinking. No matter how carefully the operation may be conducted, we never can be quite sure but that a little line will be allowed to run out after the weight reaches the bottom. If the wire was attached direct to the weight, the moment the weight reached the bottom there would be kinking; and that was one of the great difficulties. I have been told in our hydrographic department, "You need not try sounding by wire, for it is impossible! The wire goes over the rope, and the moment you try to pull it up it kinks." Therefore, instead of allowing the wire to become slack, in my first experiment I attached the weight to the clamp by 15 fathoms of cod line, and that clamp was attached to the wire. The clamp was about 4 lbs. weight. At present, in the apparatus now before you, there is a ring, weighing, perhaps, a quarter of a pound, attached direct to the wire, but I believe that it will be advisable to add weight to that ring, because I think there may be some little risk of the wire becoming slack when the weight comes to the bottom, and I should not like to trust to the wire shooting through the water with no more weight than that upon it to keep it tight. Therefore I propose to add weight to the ring, so as to bring it up to 3 lbs. or 4 lbs. Well, now, of course everything depends upon the stopping when the weight comes to the bottom, because if you do not accomplish that, then the bugbear of the wire coiling on the bottom, and kinking when you draw it up, will be a reality. The mode by which I secured that there shall be very little more line paid out from the ship after the weight reaches the bottom is simply this. A measured resistance is applied systematically to the wheel, which resistance is always to be more than enough to balance the weight of the wire out. Suppose, for example, we apply a resistance exceeding by 10 lbs. the weight of the wire out. The sinker which I have used is 30 lbs., the clamp 4 lbs. We have, then, 34 lbs. between the clamp and sinker. There is the resistance of 10 lbs. exceeding the weight of the wire out, and thus we have 10 lbs. off the 34 lbs. of the sinker and clamp. That is, we have 24 lbs. weight for the moving force. That, I have found, is amply sufficient to give a very rapid descent,—a descent so rapid that certainly in the course of half-an-hour, or three-quarters-of-an-hour, the bottom would be reached even at a depth of 2000 or 3000 fathoms. Then, of course, there must be great care in paying out the wire. The person in charge must watch. We have a counter here for the time. You cannot see it, for it is on the far side, but I dare say that every member of the Society of Telegraph Engineers can imagine a counter for counting the time. The person in charge watches the counter, and for every 250 fathoms (that is, every 250 turns of the counter), he adds 3 lbs. to the break. That makes 12 lbs. added to the break, or to the resistance, for every 1000 fathoms. The weight of 1000 fathoms of the wire in the air is 14½ lbs. In water, therefore, the weight is about 12 lbs.; so that if the weight is added at the rate I have indicated, the rule stated will be followed. That is to say, you commence with a certain weight, and you keep adding to it as the wire goes out. Well, when the weight suddenly reaches the bottom, instead of there being a pull, or a moving force, of 24 lbs. on the wire tending to draw it through the water, there will suddenly come to be a resistance of 10 lbs. against its motion. A few turns of the wheel—two or three at the most—suffice, and the motion is stopped; and, therefore, long before the clamp gets to the bottom, if we have 10 fathoms of line between the weight and the clamp, the wheel stops. The instantaneous perception of the bottom, when this rule is followed, is very remarkable. In the American process they describe the result as being most satisfactory. In their case, the wheel simply stops when the weight comes to the bottom; and they will detach, as I have said, and begin the hauling in direct on the wheel. My process differs from the American process in the mode of hauling in the wire again. [Sir W. Thomson demonstrated the method of hauling in by means of his wire-sounding apparatus]. We suppose the bottom to have been reached. In a moment the wire wheel is run back, and the wire gets upon the pulley. Observe, it has been paid straight down into the sea. We have a spun yarn stopper, which is put on in the usual way. In fact, two men with thick leather gloves can stop the wire by their hands, but the stopper is so quickly put on that I prefer it. The wire is then held by the stopper, the strain is taken off, and the weight is held by the wire. We then just carry the wire over the top of this wheel. If the depth be anything under 3000 fathoms, I should say one line round is quite enough. For 4000 fathoms I would take it twice over the wheel. It will work well enough when taken over twice, but a little more care is necessary. The stopper is now ready to go, and we haul in. The hauling in is conducted on just the ordinary sailor's plan, and the slack is taken off round a drum. By this process we can, by a few turns, relieve nine-tenths of the weight as it is coiled on the wheel. With one turn we can very readily take off three-quarters of the stress. I need not go more into detail as to process for accelerating the matter. I may just say that there are plenty of men available. Instead of handles I put on a pulley with a sharp V groove, one on each side; and then, with a snatch block, and with a deck 10 fathoms in board, the wire can be hauled tight; and three men hauling on one side, and three on the other, can get this up at a very rapid rate. By multiplying the speed in that way, there is no difficulty in hauling in at the rate of about 8 nautical miles an hour, so that the hauling in from a depth of 3000 fathoms will be done in about 25 minutes at the utmost when proper arrangements are made. Of course if there is a very heavy sea, augmenting considerably the stress above the mean stress, then slower hauling in will be practised. A little arrangement will be made by which the men can haul in as fast as they please, and be unable to put on more than a certain force. There will be the benefit of speed. It will come in fast when the strain is easy, and not come in at all when the ship is riding and would break the wire. That arrangement is exceedingly easy when we use the handles in the way that I suggest. The advantages of this process I think are very obvious. You see the simplicity of the apparatus and the comparative inexpensiveness of it. No donkey-engine, no three or four hundred pounds of iron cast away every time, and so on, as in the ordinary soundings; and withal there is a very much surer sounding than the ordinary process can give at the same depths. And lastly, there is the possibility of effecting a sounding in cases in which, as in the case of the *Challenger* in the gulf-stream, the most mature previous process fails altogether. I think it highly desirable that this process should be taken up by our own Admiralty. There is a great tendency to the other side. I have a semi-official letter to the effect—"When you have your apparatus perfected, we may be ready to try it." I may say that it seems a little strange that, after my having intimated, in the month of June, 1871, the perfect success of wire for sounding in depths of 2700 fathoms, the *Challenger* was allowed to go to sea without taking advantage of this process, and that a year and a half later I should be told—"When you have perfected your instrument we will give it a trial." The American navy looked upon the matter with different eyes, and certainly in a different spirit. They moved those who had the direction, and they took it up with the very greatest zeal. They found my apparatus full of defects, but they never asked me to perfect it, but they perfected it in their own way, and obtained results. I went on independently in another line, and made a considerably different apparatus from that which is now being used by the Americans; but I certainly was very much struck by the great zeal and the great ability which the American naval officers showed in taking up a thing of this description which had once been proved to be good, and charging themselves with improving the details, and making it a workable process. If I may be allowed two or three minutes longer, I will describe the method of making flying soundings with wire. In the first *Hooper* expedition from Pernambuco to Para, the Brazilian Government sent a gun-boat with us to take soundings, but the coal would not carry her the whole way, and we were left to our own resources for soundings during the laying of the cable. The whole route had been sounded over previously by the Brazilian Telegraph Company, so as to form a general idea of the line to be taken by the cable, but still it was very important that soundings should be taken accurately. Accordingly, Captain Headingley arranged that the wire wheel should be set up over the stern of the *Hooper*, and soundings were taken every two hours without stopping the ship. A 30 lb. weight was hung on a couple of fathoms of cord, but a greater length would have been better. I believe that 5 fathoms ought to have been used. Then the wheel was simply let go with a resistance of about 8 lbs., or, perhaps, an actual resistance of not more than 6 lbs. on the circumference of the wheel. When the ship was running at the rate of 4½ knots an hour, the cable was paying out at the rate of 6 knots; and after, perhaps, 150 fathoms had run out—in some cases 175 fathoms—suddenly the wheel would get so much slower that it almost stopped. In half a turn it was obvious that there was a difference. The moment that difference was perceived, the man standing by laid hold of the rim of the wheel and stopped it. Thus they achieved flying soundings in depths of 150 fathoms with the ship going at the rate of 6 miles; and they obtained information of the greatest possible value with reference to the depth of the water and the course to be followed by the cable. I think this is of such great importance that I never would like to go to lay a cable without an apparatus for flying soundings to be regularly practised, say every two hours at the least. The warning that this practice gives of shallow water, or of too great a depth of water, has a value which, I think, the members of the Society of Telegraph Engineers will readily appreciate. There is one point which I omitted to refer to, and that is the arrangement of the stern pulley. It is arranged so that if the ship is making a good deal of lee way the wire may still be hauled in. Supposing the ship is drifting, and making lee way instead of being at right angles, we can haul just as well. The wheel turns on a horizontal axis, and there is no strain on the wire at all. A very moderate amount of drifting, especially in a sailing vessel, may produce a great alteration in the angle, but it makes no difference to the hauling of the wire. The wheel turns readily round either way, and even during the rolling of the ship you can keep the wire on the wheel. I tested it with a wire like this on the steam launch *Hooper*, and the wheel accommodated it to every quick movement of the vessel. There is one interesting topic in connection with this plan of using wire, and that is the sound produced by the wire. All the time we are employing pianoforte wire in this way we have a "sounding" in a double sense. There is always a vibration going on, and there is this use which we may make of the sounding quality of the wire. By putting a stop in a given position on the wire we can estimate the strain on the wire with great accuracy. If you stand by the wire and give it a little blow a good musical ear can tell within 10 lbs. what the strain is, simply by the sound.

Mr. **Froude** said that he had the pleasure of seeing the first specimen of sounding wire which Sir William Thomson had made before it was used. He forgot whether at that time Sir William Thomson had hit upon his extremely ingenious and nice mode of taking the strain off the wheel; but one could see at once that it was perfectly easy and must succeed. The idea of making a strong joining in the wire by a long succession of weak fastenings seemed a very instructive mode of getting over a serious difficulty. He saw from the beginning that the joints might be put together by solder, but it was obvious to him that the stiffening of the wire by the solder must have a bad effect. He thought that it was much to be regretted that the Admiralty did not at once take up Sir William Thomson's process. They were much more disposed to take up such things than they used to be; and he was rather surprised, knowing how high Sir William Thomson's authority stood, that they should have any hesitation in taking up the process. He (Mr. Froude) wished to ask how the difficulty of corrosion by salt-water was ultimately overcome. The use of oil had been under discussion.

Sir **William Thomson** said that there were two methods of guarding against rust. The Americans used oil by submerging the wheel in oil when it was out of use. Commander Becknack having carried out the process of wire sounding with remarkable success, he (Sir William) supposed that the Americans were satisfied with the preserving power of the oil thus used. On board the *Hooper* the deep sea sounding wire was preserved by caustic soda when out of use. That substance, when bought wholesale, was so inexpensive that the cost of that mode of keeping the wire from corrosion was not worth speaking of. There was, however, a good deal of trouble connected with it; but it must be remembered that that trouble would not be regarded on board a ship appointed specially for making soundings. The preserving effect of alkali upon steel was well known to chemists. It seemed to be due to the alkali utilising the carbonic acid in water, for the presence of carbonic acid in water was the great cause of iron being corroded. The fact was well established that iron would remain perfectly bright in sea-water rendered alkaline by a little quick-lime. Caustic soda was a more sure material, because we could make more certain that the water was really alkaline. He was told by a very excellent authority, Mr. James Young, the chemist, that whether caustic soda or quick-lime was used, all that was necessary in order to make sure that the pickle would be a thorough preserver of the wire was, that it should be found to be alkaline when tested with the ordinary litmus test-paper. The American experience was, that although the caustic soda preserved the wire it ate away the solder, and on that account the Americans adopted the use of oil. Oil seemed objectionable on account of the mess and slipperiness which it would cause if it got scattered about the deck; and yet the Americans seemed to manage to work with it very well.

Mr. Matthew Gray said that sixteen months ago he had occasion to lay a cable across the Bay of Biscay and previously to that time, though he had never heard of what Sir William Thomson had done, he got an apparatus made very much like the upper portion of that which was now exhibited. In going to sea with it they found no difficulty in taking the soundings in 1300 fathoms. He was not so fortunate as Sir William was in getting good wire of sufficient strength to pull up the weight, and the wire was broken two or three times. At last they constructed a weight which got left at the bottom when it touched the bottom, and with that they were pretty successful. They used oil for keeping the wire from rusting. The oil was kept in a trough, and a flat india-rubber bearing rubbed against the wire to rub off the superfluous oil and keep it from flying over the deck. That seemed to answer the purpose very well. He might mention that he also made an apparatus with a view to picking up a larger portion of the bottom than is usually done. It was shaped something like a sugar-tongs, but the jaws were not fitted with sufficient accuracy, and the water washed out the material which the tongs took up. He had no doubt that in all cable-laying in the future much would be done by the apparatus which Sir William Thomson had constructed.

Captain Hull said that in his surveying experience he had had very little to do with deep sea soundings, but, in consequence of what he had heard that night, if he was sent to perform deep soundings, he should apply for his ship to be fitted with such an apparatus as Sir William Thomson had described. He (Captain Hull) thought that some modification might be made in the mode of taking flying soundings by the use of an old-fashioned implement used by sailors. It was a kind of floating pulley connected with a little canvas bag, which would indicate when the bottom was reached by acting in the reverse way to a float such as is used in ordinary fishing.

Mr. Matthew Gray said that he should like to know how it was that Sir William Thomson's pulley was so much injured by the weight of the wire, and why it would not do for the wire to drop up direct from the pulley. He (Mr. Gray) did not find any difficulty arising from that cause. Perhaps Sir William Thomson would say whether he brought up anything from the bottom, and if so, how he did it.

Mr. Latimer Clark asked how the friction strain on the wheel was regulated and adjusted, and also whether the sinker was recovered in flying soundings.

Professor Clerk Maxwell asked whether cross-filing of the wires at a splice for increasing the grip would do so much harm by weakening the wires as to outbalance the advantage of the increased hold.

Sir William Thomson, in reply, said that cross-filing to prevent slipping would injure a wire by taking away its strength more than it would help in increasing the friction. Marine glue was found to answer so well that he did not think that any process of roughening was necessary. For regulating the resistance, he used a form of brake which he patented in the year 1858, and he had used it in his own laboratory ever since, though it had not come into general use. It had answered very well, and he believed that it might be used with advantage in paying out a cable, although there were difficulties in the case of a cable which could not be rashly dealt with. Besides the groove which carried the wire, there was a groove with a semicircular section into which the rope was placed one turn and a quarter round the wheel. The end of the rope was secured to a pivot. [The use of the brake was demonstrated]. The question of regulating the resistance might be answered in this way. The difference of tension of the cord at the heavy tension end where the weights were attached and the light tension end was equal to the resistance. He had used a spring balance at one end. The method was to note what a spring balance was standing at, and then subtract it from the weight. That would show what force was on. He had another appliance. It consisted of simply casting off the cord, and putting on a hook over the rim of the wheel. This was carried over the pullies, and with a cleet was hauled off on a spring balance. The spring balance would weigh with the greatest accuracy the stress upon the wire. With regard to Captain Hull's suggestion as to the use of the canvas float in flying soundings, no doubt it would increase the accuracy of the sounding, but it would induce some degree of complexity, which must be avoided. As to the recovery of the weight, he might say that they always accomplished it, and they never lost a pound of lead if they could help it. His process was in this respect a great contrast to the ordinary method. Six men would be required to bring up the ordinary heavy sinker. There was also a great saving of time as compared with the ordinary method. At 2000 fathoms the wire would take not more than ten minutes to run down. A 30 lbs. sinker might be hauled after a depth of 2 miles in fifteen minutes. In fact, twenty minutes could be made sufficient for a 2500 fathom sounding when the object was to perform the sounding in the shortest possible time. The flying soundings of which he had spoken were only approximately correct, but they were useful as guides in the laying of a cable, and a little experience would enable the observer to make such an allowance as would give the accurate depth. Mr. Gray had put a question about specimens of the bottom. He (Sir William Thomson) had obtained specimens of the bottom by means of a butterfly valve of the ordinary pattern. Mr. White had made an improvement on the butterfly valve, and many other improvements had been made upon it.

The Chairman expressed the thanks of the Society to Sir William Thomson for his interesting communication. Like most other mechanical arrangements, the method which had been described was not absolutely new, and he (the Chairman) was not surprised to hear that attempts had been made to sound by means of wire instead of line; but the merit of the present apparatus, as well as of any other well-advised mechanical arrangement, consisted of the appliances to make the result a perfect one, and in that respect the apparatus would commend itself without any words from him. There were many difficulties which presented themselves at first sight against the use of wire for soundings, but they were met in the most perfect and ingenious manner. First of all, to get wire of such uniform strength as to reach to a depth of three miles required very considerable attention.

Nevertheless, piano-forte wire offered extraordinary strength and a certain degree of toughness, and was, therefore, a very inviting material; but how to join the wires in such a manner as to be thoroughly reliable was a matter requiring very mature consideration, and this difficulty had been met in the most perfect manner. Then the mode of checking the motion of the drum by a single rope, though in itself involving only a pony brake, was a very ingenious adaptation of means to the particular end, and it was brought in usefully for telling in the most absolute manner when the weight struck the bottom. There were other points of great ingenuity about the machine, and he had not the least doubt with regard to its practical value in making deep-sea soundings by wire. He had himself made deep-sea soundings some years ago, and he knew that for a depth of 2000 or 2400 fathoms they always took up the best part of the day, or at least some four or five hours, and it was a very difficult matter sometimes to keep the stern of the ship over the line. The latter friction of the line in the water was so great that the load would not follow, and therefore the ship had to be manœuvred so as to keep over the line. The wire apparatus, instead of occupying five hours, accomplished a complete deep-sea sounding in thirty-five minutes. That was a matter of really the highest importance, especially in making the soundings for a submarine line, where time was sometimes a very great object. The flying soundings were also matters of great interest. If they could be accomplished with any degree of certainty with this apparatus, it would be a great achievement. For his own part, he had sent out the apparatus with every ship which he had lately had to fit for sea.

The remaining business on the programme was deferred to the meeting to be held on the 13th May.

Correspondence.

THE NEW CONTACT THEORY OF THE GALVANIC CELL.

To the Editor of the Telegraphic Journal.

Sir,—In your next number, will you kindly point out the discrepancy in my notes of "The New Contact Theory of the Galvanic Cell?" On account of two or three words being omitted, the paragraph conveys a meaning quite opposite to what was intended. It should read as follows:—"This *battery* is an important discovery; for it seems to support the theory that chemical action *on dissimilar metals* is not necessary in a galvanic apparatus to produce electricity."—I am, &c.,

The Contributor.

Electrical Science in English and Foreign Journals.

(In addition to our usual abstracts, there will be found under this heading the titles of papers on electrical science which have appeared in English and foreign journals from the commencement of the present century up to the date of the establishment of this journal).

Poggendorff's Annalen der Physik und Chemie.

Vol. I. (1824).

Electricity Produced through Contact of Heterogeneous and Homogeneous Metals. MM. Bischof and V. Münchow. P. 279.

The Theory of Magnetism. M. Poisson. P. 302.

The Daily Variation of the Magnetic Needle. Mr. Barlow. P. 329.

Certain Motions Produced in Liquid Conductors when Traversed by an Electric Current. Mr. Herschel. P. 351.

Some Phenomena Produced by the Action of Magnetism. Mr. Abraham. P. 357.

Report on Construction of Lightning Conductors; by a French Commission. P. 403.

Vol. II. (1824).

Electromotive Phenomena Produced by Contact of Metals with Liquids, and an Attempt to Ascertain, by Means of Electro-Magnetic Action, the Changes Undergone by Certain Liquids in Contact with Air. M. Becquerel. P. 69.

Development of Electricity in Chemical Actions, and on the Distribution of Electricity in the Voltaic Pile (with Reference to Electromotive Actions of Liquids on Metals). M. Becquerel. P. 180.

Electromotive Actions of Liquids on Metals, and on Electric Actions Occurring on Contact of Certain Flames with Metals and in Combustion. M. Becquerel. P. 191.

Experiment by MM. Ampère and Becquerel Regarding the Nature of the Electric Current. M. Ampère. P. 206.

Observations on Electricity Produced in Minerals through Heat. D. Brewster. P. 297.

Vol. III. (1825).

Notice on a Physical Paper, "The Process of the Galvanic Circuit," with Remarks on Becquerel's Electromotive Researches, and on the Distribution of Magnetism in the Closed Circuit. M. Pohl. P. 183.

Application of Electric Combinations to Protection of the Copper Sheeting of Ships and Other Uses. Sir Humphry Davy. P. 211.

The Intensity of Magnetism in North Europe. M. Hansteen. Pp. 225, 353.

The Theory of Magnetism. M. Poisson. P. 429.

Vol. IV. (1825).

The Law According to which Metals Conduct Contact-Electricity. M. Ohm. P. 79.

Causes which Determine the Amount of Electric Tension. M. Walcken. P. 89.

An Attempt to Form a Magnetic-Inclination Map, from Observations by Ross and Parry's North Polar Expeditions. M. Hansteen. P. 277.

Professor Naumann's Magnetic Observations in Norway. P. 287.

Causes of Excitation of Electricity. M. Walcken. Pp. 301, 443.

Vol. V. (1825).

The Law of the Electric Force of Repulsion. M. Egen. Pp. 199, 281.

Vol. VI. (1826).

Magnetic Polarisation of Metals and Ores through Difference of Temperature. M. Seebeck. Pp. 1, 133, 253.

Experiments to Determine the Intensity of Terrestrial Magnetism, and Observations on the Daily Oscillations of the Horizontal Magnetic at Hammerfest and Spitzbergen. Mr. Sabine. P. 88.

Influence of Temperature on the Intensity of Magnetic Force, and on the Daily Variations in Intensity of Terrestrial Magnetism. Mr. Christie. P. 239.

Corrections and Additions to Paper in Vol. III. on the Intensity of Terrestrial Magnetism. M. Hansteen. P. 309.

A New Magnetic or Electro-Magnetic Observation. M. Muncke. P. 361.

Attempt at a Theory of the Electroscopic Phenomena Produced by Galvanic Forces. M. Ohm. P. 459.

Magnetising Force of Refrangible Solar Rays. Mrs. Mary Somerville. P. 493.

Vol. VII. (1826).

Attempt at a Theory of the Electroscopic Phenomena, &c., (Continued). M. Ohm. P. 45.

A Proposal for Measurement of Magnetic Deflection. P. 121.

The Magnetism Excitable in all Metals by Division. M. Seebeck. P. 203.

Magnetic Phenomena Produced by Motion. M. Arago. P. 385.

Vol. VIII. (1826).

A Remarkable Lightning Stroke. M. Muncke. P. 37.

The Present Position of the Magnetic Equator. M. Dupeney. P. 175.

Deflection of the Magnetic Needle by the Current of an Ordinary Electric Machine and Atmospheric Electricity. M. Colladon. P. 336.

Extract from a Treatise on Magnetisation. M. Savary. P. 352.

Influence of Electricity, Excited through Metallic Contact, on the Deposit of Carbonate of Lime in Lead Tubes. P. 523.

(To be continued).

Comptes Rendus Hebdomadaires des Séances de l'Academie des Sciences, Vol. lxxviii., No. 13.

An Electro-Self-Acting Whistle for Locomotives.—By MM. Lartigne.—This self-acting whistle is to supplement the system of semaphores. A lever is held in position by an electro-magnet (Hughes's system), and on a current of a determined direction entering the bobbins, the lever falls, opens a valve, and the whistle sounds. The magnet is in connection with an apparatus projecting from the engines. On the semaphore being placed at danger, a pole, furnished with a metal arm, in connection with a battery, and placed in the roadway, is in a position to momentarily close circuit with the electro-magnet by contact with the apparatus on the engine. Some of the French railway companies tried the invention on their lines for eight months, and are so satisfied with the results as to adopt the system.

Les Mondes. Vol. xxxiii., Nos. 14 and 15. April 2 and 9, 1874.

These numbers contain nothing relating to electrical or telegraphic science.

Journal of the Telegraph. Vol. vii. No. 3. February 1, 1874.

Several Cases of Intermittence of the Voltaic Current.—M. Cazin.—The first experiment was briefly this:—A coil, connected with a battery, passed round an iron tube; the circuit could be opened or closed by a platinum point, which dipped in mercury. If, the platinum and mercury being first separated, they were put in communication with the armature of a condenser, or if a layer of alcohol was interposed between the mercury and the platinum point, a continuous sound was heard in the iron core (it ceased if the alcohol was suppressed or the point dipped in the mercury); this indicates that the current passed through the glass in the former case, through the alcohol in the latter, and that its passage was intermittent. The iron core undergoes a rapid series of magnetisations and demagnetisations. The author thinks the cause of the intermittence is the condensing action of glass and of alcohol. When the two faces of the insulating substance have acquired a certain electric potential, a discharge takes place through the insulating layer. The magnetism of the core grows during the charge of the condenser, and diminishes during its discharge. The sound is produced during the diminution of magnetism. The second experiment refers to the spark of rupture, which, produced in alcohol in the above arrangement, is observed to be compound, and the sound it gives presents a similar mode of division. The production of a sound in the condenser also proves that there is a partial discharge through the insulating matter, although this appears nowhere to be perforated. In a third experiment the platinum point could be moved up and down in its support by screwing. Dipping in the mercury, it is gradually raised till the spark passes through the alcohol; then a succession of sparks occur, and continues some time. The surface of mercury evidently oscillates under the point. One possible cause of this is that, the spark being formed by mercury vapour, the elastic force of this vapour depresses the surface of liquid. The latter returns to its original level, passes it in virtue of acquired velocity, and rejoins the platinum point. Falling back, it produces a new interruption, and so on. But this cannot be the only cause, for the circumstances favourable to this automatic interruption are those which accompany the decomposition of the spark of rupture into a small number of bright successive lines. By changing the extent of the condenser one may change the number of divisions in the spark. If the condenser be suppresed there will merely be a crepitating voltaic arc. Probably the period of oscillation of the mercury and the intermittence of discharge of the condenser are in mutual dependence. The crepitations of the ordinary voltaic arc are, the author thinks, a phenomenon belonging to the class above indicated. All the facts permit of being united by the following proposition:—The interposition of a suitable resistance in the voltaic circuit causes intermittence of current. Further, the important conclusion is warranted that the current is a succession of modific ations which are accomplished periodically in the circuit.

Fraser's Magazine. New Series. No. 52. April, 1874.

The Postal Telegraph Service.—Archibald Granger Bowie.—This elaborate and lucid article describes the routine of the respective branches of the service which the Government have organised to carry out certain definite advantages that were to accrue to the public by the change from private companies to the state. The organisation of the several branches by which these advantages were to be supplied was an arduous work to establish. The great facilities offered now to the public in the cheapness, rapidity, and regularity with which messages are transmitted from one part of the kingdom to another afford proof of the success of the routine devised and controlled by Mr. Scudamore, the Postmaster-General, Mr. Culley, the engineer-in-chief, and the several divisional engineers by whom they are assisted. The respective branches of the service by which this work is done includes the *Telegraph Branch of the Secretary's Office*. This branch is, for convenience, sub-divided into seven sections, six of which may be concisely described as the "Private Wire Sections," the seventh, "News Section." Next comes the *Telegraph Account Branch*, the *Telegraph Message Branch*, and the *Telegraph Clearing-House Branch*. The *Telegraph Clearing-House Branch* has been established since 1871. The novel feature of it is that it is worked by a staff of ladies. Here a certain number of messages are examined daily, and all discovered errors are reported to the post-office with which the fault lies. Mr. Scudamore says the operation of the clearing-house check has been very salutary. The article contains some interesting statistics from the Postmaster-General's report for 1872.

City and Commercial Notes.

We have received from the Oriental Telegram Agency, Limited, their "Social Code Book," which offers to the public the usual advantages accompanying code messages, namely, economy, secrecy, and accuracy. This company has instituted a novel feature in telegraphy, by establishing a system which is called the *Social Department*. It consists in registering the addresses of subscribers who pay five shillings per annum, in connection with the name and address of any friend abroad, whereby a large outlay is saved which would otherwise be spent in constantly paying for the full names and addresses of sender and receiver instead of one code word only. When a subscription is paid, the advice of such registration is forwarded by post to the company's agency abroad, and as soon as its receipt is acknowledged (by telegraph), a card is forwarded to the subscriber announcing that the service is open to him for twelve months from that date. This system is of immense benefit to business firms, or to Anglo-Indians at home,—for instance, wives whose husbands are abroad, and to whom messages may frequently be required. By these the Social Department has been well supported. We are informed that the cost of telegrams transmitted through this agency will be found from forty to fifty per cent below the Cable Company, when sent direct by the usual method. The "Social Code" shows evidence of great care having been spent over it, and will, we doubt not, well answer the purpose for which it has been issued.

The report of the trustees of the Submarine Cables Trust to the third ordinary annual meeting of the certificate holders, held on Wednesday, the 29th inst., states that the revenue for the financial year ending April 15, 1874, has amounted to £33,525 15s. 4d., and the expenses (limited by the trust deed to £2000) have been £1924 10s. 5d., leaving a balance of £31,601 4s. 11d.

The shareholders of the Western and Brazilian Telegraph Company have been invited to subscribe to £100,000 ten per cent loan for twelve months, to enable the Central American Telegraph Company to complete the connections of the Western and Brazilian Cables with the West Indies and New York. The loan is to be secured by a deposit of shares, and the Western Company guarantee its repayment.

TELEGRAPH SHARE LIST.

Amount per Share.	Name of Company.	Amount paid up.	Closing Quotations.
£		£	April 29.
Stock	Anglo-American (Limited)	100	71—72
10	Brazilian Submarine	All	6¾—7¼
10	Cuba	All	7½—8
10	Direct Spanish	9	..—..
20	Direct United States Cable	All	14½—15½
10	Eastern (Limited)	All	6⅞—7⅛
..	Do., New	..	101—103
10	Eastern Extn. Australia and China	All	7½—7¾
10	Globe Telegraph and Trust	All	6¼—6½
10	Do., 6 per cent Pref.	All	9⅛—9⅜
10	Great Northern	All	9¾—10¼
25	Indo-European	All	15½—16½
10	Mediterranean Extension (Limited)	All	4—4½
10	Do., 8 per cent Pref.	All	11—12
10	Panama and South Pacific	2½	..—.. dis.
8	Reuter's	All	11—11½
Stock	Submarine	100	220—225
1	Do., Scrip	All	2—2¼
10	West India and Panama	All	4¾—5
10	Do., 10 per cent Pref.	All	9⅝—9⅞
20	Western and Brazilian (Limited)	All	11—12
1000 dls.	West Un. U.S. 7 per cent 1st M.B.	All	105—107
10	Hooper's Telegraph Works	All	11¾—12¼
50	India-Rubber and Gutta Percha	All	21—23
Cert.	Submarine Cables Trust	100	105—108
12	Telegraph Construction	All	30½—31½
100	Ditto Ditto 7 per cent Bonds	All	102—104

The Indo-European Telegraph Company announce that the Indian Department will now accept as single words all ordinary English words, proper names of persons and places, which are commonly written and recognised as one word.

Patents.

2015. A. V. Newton, of Middlesex, mechanical draughtsman. (A communication from J. D. Wallace, of New York, America). *Improvements in Electro-Magnetic Engines or Motors.* Dated June 5, 1873.—This invention consists firstly in a peculiar construction of the magnets of broken annular sections; the invention furthermore includes a novel operation of a permutator.

2053. J. H. Sandy, of London. *Improvements in Galvanic Batteries, and in the Fittings, Mountings, and Apparatus connected therewith.* Dated June 10, 1873.—Constructing galvanic batteries with a frame or frames carrying pads and capable of being raised so that the pads are drawn up and forced between the plates when the battery is required for use, and lowered and withdrawn from between them when the battery is put out of use, and these movements may be effected by the opening and closing of the battery box. Below the plates and quite clear of them is an acid receiver, to be filled with sponge or such like material, and into and against which the pads are pressed when lowered down from between the plates, and they become charged with acid by capillary attraction. Along the top of the battery is a bar, upon which is fitted to move back and forth a traversing "coupler," by which the number of pairs of plates to be brought into action is regulated.

2077. W. Rowett, of Lancaster. *Improvements in the Construction and Manufacture of Electric Telegraph Cables or Ropes.* Dated June 11, 1873.—Consists in covering the wire conductor with Rowett's non-masticated india-rubber; in placing two or more wire conductors in a single cable for ocean purposes, without adding to its bulk; in adding strength to the cable by filling its interstices with the strongest hemp or fibre lines producing a solid spherical core; in preserving from decay all the hemp or fibrous material of which the cable is composed by Rowett's preserving compound; in laying the strands of the envelope on the core with Rowett's preserving elastic marine glue; in substituting an envelope of hemp prepared with Rowett's preserving marine glue round the electric conductor, for the usual insulating compound of gutta-percha, india-rubber, &c.; in making the cables of coir fibre, African or Indian grass, to produce light specific gravity; in making the envelope of wrong-way yarn, drawn from conical spindles, instead of the bobbins now in use.

2091. H. A. Bonneville, of Paris and of Middlesex. (A communication from W. Radde, of New York). *Certain Improvements in Conductors for Telegraph Wires.* Dated June 13, 1873.—Consists in the arrangement of an insulated bridge enclosed in a box which forms the connecting link between sections of pipes enclosing one or more telegraph wires in such a manner that by opening said box access can be had to the wires whenever it may be desirable; also in a pipe containing a series of insulated passages in such a manner that a separate passage is obtained for each of a series of telegraph wires in the smallest possible compass.

2101. F. H. Greer, of Middlesex. *Improvements in Telegraphing and in Collecting Electricity for Telegraphing and Other Purposes.* Dated June 13, 1873.—The establishing of an electrical circuit by uniting of the electrical stratum or belt (high in the air) with the earth current for telegraphing and other purposes, such as generating mechanical power, heat, light, electro-plating, electro-photographing, &c. Dispensing with ordinary batteries, and without using a cable or wire to connect the vanes or towers on the peaks of high mountain stations. The circuit being broken and closed gives a corresponding effect, or is repeated at all the vanes that are connected by the electrical circuit or aërial ocean of electricity. A vane or cone for collecting, distributing, and utilising air-currents of natural or atmospheric electricity for telegraphic and other purposes, the said vane being constructed of two or more sections insulated from each other. The said vane or cone to swing on an insulated tower or post.

2103. D. G. Fitz-Gerald, of Surrey, and B. C. Molloy, of Middlesex. *Improvements in the Construction and Working of Voltaic Batteries.* Dated June 13, 1873.—This Provisional Specification describes a voltaic couple in which the negative element divides the cell into two compartments. One compartment contains the positive element and the other a solution capable of oxidising nascent hydrogen. The Provisional Specification also describes other improvements in voltaic batteries.

2133. G. Little, of New Jersey, America. *Improvements in Automatic Telegraph Apparatus for Preparing Paper and Transmitting and Receiving Messages.* Dated June 17, 1873.—(A description of this has already formed subject-matter for an illustrated article in our number of February 1, 1874).

2225. C. W. Siemens, of Middlesex. (A communication from Dr. W. Siemens and F. von H. Alteneck, of Berlin). *Improvements in Electrical Apparatus for Sending by means of Finger Keys and for Receiving and Printing Telegraphic Messages, parts of these Improvements being also Applicable to Electric Telegraph Apparatus generally.* Dated June 27, 1873.—This invention relates to apparatus for sending by means of finger keys currents of electricity in various combinations and successions, for equalising and directing electrical currents, and for receiving currents and applying them for marking or printing symbols or characters depending upon the combination and succession of the currents received. The finger keys are arranged in combination with levers and other mechanism so as to push transversely sliding pins mounted in a travelling chain or to move slides mounted on a revolving drum, the pins so protruded or the slides so shifted serving to make contacts for the transmission of electrical currents by a line wire. Currents transmitted by a line wire are directed and equalised in duration by contact making instruments combined with electro-magnets so arranged that contact when made is immediately broken, and thus a current, whatever be the duration of contact for it at the sending instrument, is permitted to act only for a short period on the receiving instrument. Positive and negative currents are employed for working a type-wheel step by step, or for moving a slide or turning a drum, arranged so that the number of currents necessary for bringing a particular type into action are reduced by causing a current of the one direction to turn the type wheel a number of steps, such as four, while a current of the other direction turns itone step, or by causing a current of the one direction to move the slide or drum longitudinally while a current in the other direction moves the slide transversely, or the drum round its axis. And such currents are also employed to move two markers which make contacts so as to render active by their particular combinations electro-magnets that work particular types.

2266. G. Zanni, of Middlesex. *Improvements in Magneto-Electric Morse Ink Printing Telegraphic Apparatus.* Dated June 30, 1873.—This invention has for its object improvements in magneto-electric Morse ink printing telegraphic apparatus arranged in accordance with "Zanni's system" having inking apparatus applied thereto.

2302. W. R. Lake, of London. (A communication from H. T. Brownell, of Hartford, Connecticut, America). *Improved Processes for Plating Iron, Steel, and Other Metals with Nickel.* Dated July 2, 1873.—I apply nickel to the iron, steel, copper, brass, or other metals, either by electro-plating or any other of the ordinary methods of covering metals, with a thin film of nickel, and then subject the metal so plated to a temperature of from 480° to 700° F., or the metal is first heated in water at or near the boiling point, and is then immersed in the plating fluid heated to the same temperature.

2232. F. H. Varley, of the firm of O. and F. H. Varley, of Middlesex. *Improvements in Transmitting and Recording Telegraph Signals, and Means of Transcribing and Apparatus connected therewith.* Dated June 27, 1873.—The chief features of novelty in this invention mainly consist as follows.—The means by which magnetised arms or arm, whether induced or permanent, are maintained in a uniform field of magnetic rays, so that whatever be the deflection of the arms or arm which bear a definite proportion to the current traversing through the coils, the polar influence of the induced magnetism shall be equal as the arms or arm move at right angles to the rays of the permanently induced magnetism. The means by which at one view the signals are seen superposed on the paper or tablet used for transcribing the signal or message, employing for this purpose alternate reflection and transmission of light so as to obtain double vision in a manner easy of management. The means of combining the audible and visual or permanently recorded signals or messages to enable the concerted employment of the faculties of vision and hearing, and the use of a moving arm on which the paper strip passes under and over to obtain mark concurrent with the sound produced by the armature beating against the adjusted stops. The employment of a capillary syphon of a porous substance or fabric to effect electro-chemical continuity whilst the electro-chemical excitants are maintained mechanically separate, by which means a constant battery is obtained with small internal resistance substantially herein described.

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